

Gulf Cooperation Council

EDICT OF GOVERNMENT

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GSO 208 (1994) (English): Industrial safety and health regulations - Part 2: Buildings -Sections 2.7, 2.8, 2.9 - Fire protection.



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اشتراطات السلامة والصحة الصناعية

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الوقاية من الحرائق

**INDUSTRIAL SAFETY AND HEALTH
REGULATIONS - BUILDINGS - PART 2:
FIRE PROTECTION**

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INDUSTRIAL SAFETY AND HEALTH REGULATIONS - BUILDINGS - PART 2: FIRE PROTECTION

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**INDUSTRIAL SAFETY AND HEALTH
REGULATIONS - BUILDINGS - PART 2:
FIRE PROTECTION**

1. SCOPE AND FIELD OF APPLICATION

This standard is concerned with fire protection in industrial buildings. It also contains requirements for stand pipe and hose systems, automatic sprinkler systems, fixed extinguishing systems using dry chemical, gaseous agent, water spray and foam fire detection systems, employee alarm systems, fire brigades, protection at construction site, fire walls and doors and explosion panels.

2. COMPLEMENTARY REFERENCES

- 2.1 GSO 79/1988 "Industrial Safety and Health Regulations - Buildings - Part 1: Building Facilities".
- 2.2 GSO 212/1994 "Industrial Safety and Health Regulations - Part 5: Personal Protection Equipment".

3. DEFINITIONS

- 3.1 After-Flame: The time a test specimen continues to flame after the flame source has been removed.
- 3.2 Aqueous Film Forming Foam (AFFF): A fluorinated surfactant with a foam stabilizer which is diluted with water to act as a barrier to exclude air and to develop an aqueous film on the fuel surface which is capable of suppressing the generation of fuel vapors.
- 3.3 Automatic Fire Detection Device: A device designed to automatically detect the presence of fire by heat, flame, light, smoke or other products and effects.
- 3.4 Combination Detector: An automatic fire detection device which responds to more than one product of combustion.
- 3.5 Flame Detector: An automatic fire detection device which detects the infrared or ultraviolet, or visible effects produced by a fire.
- 3.6 Heat Detector: An automatic fire detection device which detects abnormally high temperature and/or rate-of-temperature rise.
- 3.7 Line-Type Detector: An automatic fire detection device in which detection is continuous along a path.
- 3.8 Other Fire Detectors: Automatic fire detection devices which detect phenomenon other than heat, smoke, light or flame produced by a fire.

- 3.9 Smoke Detector: A device which detects visible or invisible particles of combustion.
- 3.10 Spot-Type Detector: A device whose detecting element is directed at a particular location.
- 3.11 Buddy Breathing Device: An accessory to self-contained breathing apparatus which permits a second person to share the same air supply as that of the wearer of the apparatus. Such devices are used for emergency escape situations.
- 3.12 Class A Fire: A fire involving ordinary combustible materials such as paper, wood, cloth, rubber, and many plastics.
- 3.13 Class B Fire: A fire involving flammable or combustible liquids, flammable gases, greases, and similar materials.
- 3.14 Class C Fire: A fire involving energized electrical equipment where safety to the employee requires the use of electrically nonconductive extinguishing media.
- 3.15 Class D Fire: A fire involving certain combustible metals such as magnesium, titanium, zirconium, sodium, lithium and potassium.
- 3.16 Discharge Alarm: An alarm which sounds when an extinguishing agent is being discharged through a system.
- 3.17 Dry Chemical: A compound composed of very small particles of sodium bicarbonate, potassium bicarbonate, urea-based potassium bicarbonate, potassium chloride, or monoammonium phosphate supplemented by special treatment to provide resistance to packing and moisture absorption (caking) as well as providing proper flow capabilities. Dry chemical does not include dry powders.
- 3.18 Dry Powder: A compound used to extinguish or control Class D fires.
- 3.19 Education: The process of imparting knowledge or skill through systematic instruction. It does not require formal classroom instruction.
- 3.20 Enclosed Structure: A structure with a roof or ceiling which may present similar fire hazards to employees as well as buildings.
- 3.21 Extinguisher Classification means the letter classification given on extinguisher to designate the class or classes for fire on which an extinguisher will be effective for control or extinguishments of a fire. For example, a Class A extinguisher would be effective on Class A fires, and a Class B extinguisher would be effective on Class B fires, and Class C extinguisher would be effective on Class C fires.
- 3.22 Fire Brigade (private fire department and industrial fire department): An organized group of employees who are knowledgeable, trained, and skilled in firefighting operations.
- 3.23 Fixed Extinguishing System: A permanently installed system that either extinguishes or controls a fire at the location of the system.
- 3.24 Flame Resistance: The property of materials, or combinations of component materials, to retard ignition and restrict the spread of flame.

- 3.25 Foam: A stable aggregation of small bubbles which flow freely over a burning liquid surface and form a rigid air-excluding blanket which seals combustible vapors and thereby extinguishes the fire.
- 3.26 Gaseous Agent: A fire extinguishing agent which has a very low density and viscosity, can expand or contract with changes in pressure and temperature, and has the ability to diffuse readily and to distribute itself uniformly throughout an enclosure.
- 3.27 Halon 1211: A colorless, faintly sweetsmelling electrically nonconductive liquefied gas (chemical formula CBrClF_2) which is a medium for extinguishing fires by inhibiting the chemical chain reaction of fuel and oxygen. It is also known as bromochlorodifluoromethane.
- 3.28 Halon 1301: A colorless, odorless, electrically nonconductive gas (chemical formula CBrF_3) which is a medium for extinguishing fires by inhibiting the chemical chain reaction of fuel or oxygen. It is also known as bromotrifluoromethane.
- 3.29 Incipient Stage Fire: A fire which is in the initial or beginning stage and which can be controlled or extinguished by portable fire extinguishers or Class II standpipe systems without the need for protective clothing or breathing apparatus.
- 3.30 Interior Structural Fire Fighting: The physical activity of fire suppression, rescue or both inside of buildings or enclosed structures which are involved in a fire situation beyond the incipient stage.
- 3.31 Local Application System: A fixed suppression system which has a supply of extinguishing agent normally connected to fixed piping with nozzles arranged to automatically discharge extinguishing agent directly on the burning material to extinguish or control a fire.
- 3.32 Maintenance: The services to be performed on fire protection equipment and systems to ensure that they will perform as expected in the event of a fire. Maintenance differs from inspection in that maintenance requires the checking of internal fittings, devices and agent supplies. It requires, at least in part, the physical breakdown, disassembly and reassembly of the unit.
- 3.33 Multipurpose Dry Chemical: A dry chemical which is approved for use on Class A, Class B and Class C fires.
- 3.34 Outer Shell: The exterior layer of materials on the fire coat and protective trousers which forms the outermost barrier between the fire fighter and the environment. It is attached to the vapor barrier and liner and is constructed with a storm flap, suitable closures, and pockets.
- 3.35 Pre-action Alarm or Pre-discharge Alarm: An alarm which will sound at a set time prior to actual discharge of the system so that employees may evacuate the discharge area prior to system discharge.
- 3.36 Quick Disconnect Valve: A device which starts the flow of air by insertion of the hose (which leads from the face piece) into the regulator of self-contained breathing apparatus, and stops the flow of air by disconnection of the hose from the regulator.

- 3.37 Sprinkler Alarm: An approved device installed so that any waterflow from a sprinkler system equal to or greater than that from a single automatic sprinkler will result in an audible alarm signal on the premises.
- 3.38 Sprinkler Systems: A system of piping designed in accordance with fire protection engineering standards and installed to control or extinguish fires. The system includes an adequate and reliable water supply, and a network of specially sized piping and sprinklers which are interconnected. The system also includes a control valve and a device for actuating an alarm when the system is in operation.
- 3.39 Standpipe Systems: Class of service.
- 3.39.1 Class 2 Standpipe System: A small hose system (3.81 cm) which provides a means for the control or extinguishment of incipient stage fires.
- 3.39.2 Class 3 Standpipe System: A combined system of hose which is for the use of employees trained in the use of hose operations and which is capable of furnishing effective water discharge during the more advanced stages of fire in the inside of workplaces. Hose outlets are available for both large and small hose (6.3 cm, and 3.8 cm).
- 3.40 Total Flooding System: A fixed suppression system which is arranged to automatically discharge a predetermined concentration of agent into an enclosed space for the purpose of fire extinguishment or control.

4. REQUIREMENTS

4.1 Portable Fire Extinguishers

4.1.1 General

- 4.1.1.1 The employer shall mount, locate and identify portable fire extinguishers so that they are readily accessible to employees without subjecting them to any possible injury.
- 4.1.1.2 Carbon tetrachloride and chlorobromomethane extinguishing agents are prohibited from use in portable fire extinguishers used by employees.
- 4.1.1.3 The employer shall maintain portable fire, extinguishers in a fully charged and operable condition and keep them in their designated places at all times except during use.

4.1.2 Selection and Distribution

- 4.1.2.1 The employer shall select and distribute portable fire extinguishers for employee use in a manner determined by the classes of anticipated workplace fires and by the size or degree of hazard which would affect their use.
- 4.1.2.2 The employer shall distribute portable fire extinguishers for use by employees on Class A fires so that the travel distance to any extinguisher is limited to 23 m or less.
- 4.1.2.3 The employer may use uniformly spaced small hose stations installed for emergency use by employees instead of Class A portable fire extinguishers

provided that such small hose systems meet the requirements of 4.2 and that they provide total coverage of the area to be protected.

- 4.1.2.4 The employer shall distribute portable fire extinguishers for use by employees on Class B fires so that the travel distance to any extinguisher is limited to 15 m.
- 4.1.2.5 The employer shall distribute portable fire extinguishers used for Class C hazards on the basis of the distribution patterns for the Class A or Class B fires associated with the Class C hazard.
- 4.1.2.6 The employer shall distribute portable fire extinguishers or other containers of Class D extinguishing agent for use by employees so that the travel distance is limited to 23 m. Portable fire extinguishers for Class D hazards are required only in those combustible metal working areas where combustible metal powders, flakes, shavings, or similarly sized products are generated on a daily basis.
- 4.1.3 Inspection, Maintenance and Testing
 - 4.1.3.1 The employer shall be responsible for the inspection, maintenance and testing of portable fire extinguishers.
 - 4.1.3.2 The employer shall conduct monthly inspections.
 - 4.1.3.3 The employer shall record the inspection dates for each extinguisher and make the record available to the concerned authority upon request. Such records shall be kept one year after entry.
 - 4.1.3.4 The employer shall empty and subject stored pressure dry chemical and Halon 1211 extinguishers that require a 12-year hydrostatic test to the applicable maintenance procedures every 6 years.
 - 4.1.3.5 The employer shall replace portable fire extinguishers removed from service (for maintenance and recharging) with spare extinguishers having the same classification.
- 4.1.4 Hydrostatic Testing
 - 4.1.4.1 The employer shall ensure that hydrostatic testing be performed by trained persons with suitable testing equipment and facilities.
 - 4.1.4.2 The employer shall have the portable extinguishers hydrostatically tested at the intervals listed in Table 1.
 - 4.1.4.3 The employer shall have the portable extinguishers hydrostatically tested when they show evidence of corrosion or mechanical injury.
 - 4.1.4.4 The employer shall perform hydrostatic tests on extinguisher hose assemblies which are equipped with a shutoff nozzle at the discharge end of the hose. The test intervals shall be the same as that specified for the extinguisher on which the hose is installed.
 - 4.1.4.5 The employer shall test carbon dioxide extinguishers and nitrogen or carbon dioxide cylinders used with wheeled extinguishers at 5/3's of the service pressure (as stamped into the cylinder) every 5 years.

- 4.1.4.6 The employer shall hydrostatically test all stored pressure and Halon 1211 types of extinguishers at the factory test pressure not to exceed two times the service pressure.
- 4.1.4.7 The employer shall test acceptable self-generating type soda acid or foam extinguishers at 24.6 kg/sq cm.
- 4.1.4.8 The employer shall test carbon dioxide hose assemblies requiring a hydrostatic pressure test at 88 kg/sq cm.
- 4.1.4.9 The employer shall test dry chemical and dry powder hose assemblies requiring a hydrostatic pressure test at 21 kg/sq cm.
- 4.1.4.10 The employer shall not use air or gas pressure for pressure testing.
- 4.1.4.11 When extinguisher shells, cylinders, or cartridges fail a hydrostatic pressure test, the employer shall remove them from service and from the workplace.
- 4.1.4.12 The equipment for testing cylinders and cartridges shall be of the water jacket type. The equipment shall be equipped with an expansion indicator which operates with an accuracy within 1 % of the total expansion or 0. 1 cc of liquid.
- 4.1.4.13 The employer shall test hose assemblies of carbon dioxide extinguishers that require a hydrostatic test within a protective cage device.
- 4.1.4.14 In addition to the visual examinations required prior to testing, the employer shall also make an internal examination prior to the hydrostatic tests.
- 4.1.4.15 The employer shall maintain and provide upon request to GSMO evidence that the required hydrostatic testing of fire extinguishers has been performed at the time intervals shown on Table (1). Such evidence shall include the date of test, the test pressure used, and the name or identification of the person or agency performing the test. Such records shall be kept for twelve years or as long as the extinguisher is in service whichever is less.
- 4.1.4.16 Hose assemblies passing a hydrostatic test do not require any type of recording or stamping.
- 4.1.5 Training and Education
 - 4.1.5.1 Where the employer has provided portable fire extinguishers for employee use in the workplace, the employer shall provide an educational program to familiarize employees with the general principles of fire extinguisher use and the hazards involved with fighting fire of limited size.

Table (1)

Type of Extinguishers	Test intervals (yrs.)
Soda acid (soldered brass shells)	* not permitted
Soda acid (stainless steel shell)	5
Cartridge operated water and/or antifreeze	5
Stored pressure water and/or antifreeze	5
Wetting agent	5
Foam (soldered brass shells)	* not permitted
Foam (stainless steel shell)	5
Aqueous film forming foam (AFFF)	5
Loaded Stream	5
Dry chemical with stainless steel or soldered brass shell	5
Carbon dioxide	5
Dry chemical, stored pressure, with mild steel brazed brass or aluminium shells	12
Dry chemical, cartridge or cylinder operated, with mild steel	12
Halon 1211	12
Halon 1301	12
Dry powder, cartridge or cylinder operated with mild steel shells	12

* Extinguishers having shells constructed of copper or brass joined by soft solder or rivets shall be removed from service.

- 4.1.5.2 The employer shall provide employees with the education required in 4.2.5.1 upon initial employment and at least annually thereafter.
- 4.1.5.3 The employer shall provide employees, who have been designated to use fire fighting equipment with hands as part of an emergency action plan, with training in the use of the appropriate equipment.
- 4.1.5.4 The employer shall provide the hands-on training required in 4.1.5.3 upon initial assignment to the designated group of employees and at least annually thereafter.

4.2 Standpipe and Hose Systems

- 4.2.1 Protection of Standpipes. The employer shall locate or otherwise protect standpipes against mechanical damage. Damaged standpipes shall be repaired promptly.
- 4.2.2 Equipment
 - 4.2.2.1 Where reels or cabinets are provided to contain fire hose, the employer shall design them to facilitate prompt use of the hose valves, the hose, and other equipment at the time of fire or other emergency. The employer shall conspicuously identify and use reels and cabinets for fire equipment only.
 - 4.2.2.2 The employer shall locate hose outlets and connections high enough above the floor to avoid being obstructed and to be accessible to employees.
 - 4.2.2.3 Where the pressure under static or dynamic conditions at any standpipe outlet exceeds 7 kg/sq cm, the employer shall install an approved device at the outlet to reduce the pressure at the outlet to 7 kg/sq cm or less with the required water flow.
 - 4.2.2.4 The employer shall standardize screw threads throughout the system and ensure that they are compatible with those used on supporting fire equipment. Use of adapters is permitted to provide compatibility.
 - 4.2.2.5 The employer shall equip each hose outlet with fire hose attached and ready for use.
 - 4.2.2.6 The employer shall equip standpipe systems installed for use by employees. with lined hose.
 - 4.2.2.7 The employer shall provide hose of such length that friction loss resulting from water flowing through the hose will not decrease the pressure at the nozzle below 2.1 kg/sq cm.
 - 4.2.2.8 The employer shall equip standpipe hose with shut-off type nozzles.
- 4.2.3 Water Supply. The minimum water supply for standpipe and hose systems, which are provided for the use of employees, shall be sufficient to provide 380 liters/min. for a period of at least thirty minutes. The supply shall be sufficient to maintain a residual pressure of 4.6 kg/sq cm at the topmost outlet with 380 liters/min.
- 4.2.4 Tests and Maintenance
 - 4.2.4.1 The employer shall hydrostatically test piping of new Class 2 and Class 3 systems including yard piping at not less than 14 kg/sq cm for a period of at least 2 hours, or at 3.5 kg/sq cm in excess of normal pressure when such pressure is greater than 10.5 kg/sq cm.
 - 4.2.4.2 The employer shall ensure that hose on all Class 2 and Class 3 systems installed be hydrostatically tested with couplings in place, before being placed in service, at a pressure of not less than 14 kg/sq cm. This pressure shall be held for at least 14 seconds and not more than one minute during which time the hose shall not leak nor shall any jacket thread break during the test.
 - 4.2.4.3 The employer shall keep water supply tanks filled to the proper level except during repairs. When pressure tanks are used the employer shall maintain proper pressure at all times except during repairs.

- 4.2.4.4 The employer shall keep valves in the main piping connections to the automatic sources of water supply fully open at all times except during repair.
- 4.2.4.5 The employer shall make inspections of systems at least semiannually and after each use to assure that all of the equipment and hose is in place, available for use, and in serviceable condition.
- 4.2.4.6 When any component of the system is found not to be serviceable the employer shall remove it from service immediately and replace it with equivalent protection.
- 4.2.4.7 Hemp or linen hose on existing systems shall be unracked, inspected for deterioration, and reracked at least annually by the employer. The employer shall replace defective hose.
- 4.2.4.8 The employer shall ensure that inspections are made by trained designated employees who can ensure that the equipment is in serviceable condition.
- 4.3 **Automatic Sprinkler Systems**
 - 4.3.1 General
 - 4.3.1.1 All automatic sprinkler designs used to comply with this standard, whether hydraulic or pipe schedule, shall be capable of providing the necessary discharge patterns, densities, and water flow characteristics for complete coverage in a particular workplace or zoned subdivision of the workplace.
 - 4.3.1.2 The employer shall use only approved equipment and devices in the design and installation of automatic sprinkler systems.
 - 4.3.2 Acceptable Tests. The employer shall conduct proper acceptance tests on sprinkler systems installed for employee protection and record the dates of such tests. Proper acceptance tests include the following:
 - 4.3.2.1 Flushing of underground connections.
 - 4.3.2.2 Hydrostatic tests of piping in system.
 - 4.3.2.3 Air tests in dry-pipe systems.
 - 4.3.2.4 Dry-pipe valve operation.
 - 4.3.2.5 Test of drainage facilities.
 - 4.3.3 The employer shall provide every automatic sprinkler system with at least one automatic water supply. The water supply shall be capable of providing design water flow for at least 30 minutes. An auxiliary water supply or a mandatory employee evacuation plan shall be provided when the automatic water supply is out of service. Auxiliary water supplies are not required for systems of 20 or less sprinkler heads.
 - 4.3.4 The employer shall protect automatic sprinkler system piping against freezing and exterior surface corrosion.
 - 4.3.5 The employer shall install all dry sprinkler pipe and fittings so that the system may be totally drained.
 - 4.3.6 The employer shall not permit torch cutting as a means of modifying or repairing sprinkler systems.

- 4.3.7 Sprinklers
 - 4.3.7.1 The employer shall use only approved sprinklers on systems.
 - 4.3.7.2 The employer may use older style sprinklers to replace similar style sprinklers, but not for replacing standard sprinklers without a complete engineering review of the system.
 - 4.3.7.3 The employer shall protect sprinklers which are located so as to be subject to mechanical injury from such injury with effective guards.
- 4.3.8 On all sprinkler systems having more than 20 sprinklers, the employer shall provide a local waterflow alarm which sounds an audible signal upon water flow through the system equal to that from a single automatic sprinkler.
- 4.3.9 The employer shall space sprinklers to provide a definite maximum protection area per sprinkler, a minimum of interference to the discharge pattern by building or structural members, or building contents and suitable sensitivity to possible fire hazards. The minimum vertical clearance below and between heads and obstructions shall be 50 cm.
- 4.3.10 The employer shall identify hydraulically designed automatic sprinkler systems or portions thereof and indicate the location, number of sprinklers in the hydraulically designed section and the basis of the design. Central records may be used in lieu of signs at sprinkler valves provided the records are available for inspection and copying by the concerned authority.
- 4.4 Fixed Extinguishing Systems
 - 4.4.1 General
 - 4.4.1.1 Fixed extinguishing systems, components, and agents shall be designed and approved for use on the specific fire hazards they are expected to control or extinguish.
 - 4.4.1.2 If for any reason a fixed extinguishing system becomes inoperable, the employer shall notify employees and take the necessary temporary precautions to ensure their safety until the system is restored to operating order. Any defects or impairments shall be properly corrected by competent personnel.
 - 4.4.1.3 The employer shall provide a distinctive alarm capable of being perceived above ambient noise or light levels on all systems in the protected area to indicate that the system is discharging.
 - 4.4.1.4 The employer shall provide a distinctive alarm capable of being perceived above ambient noise or light levels to warn employees against re-entry into discharge areas where the atmosphere remains hazardous to employee safety and health.
 - 4.4.1.5 The employer shall post hazard warning or caution signs at the entrance to, and inside of, areas protected by fixed extinguishing systems which use agents known to be hazardous to employee safety and health.
 - 4.4.1.6 The employer shall ensure that fixed systems are inspected annually by a person knowledgeable in the designed function of the system to ensure that the system is maintained in an operating condition.

- 4.4.1.7 The employer shall check the weight and pressure of refillable containers at least semi-annually. If the container shows a loss in net content or weight of more than 5 percent or a loss in pressure of more than 10 percent, it shall be subjected to maintenance. Records of semi-annual checks shall be kept available at the workplace for at least 6 months after entry.
- 4.4.1.8 The employer shall weigh factory charged non-refillable containers which have no means of pressure indication at least semi-annually. If a container shows a loss in net weight of more than 5 percent it shall be replaced.
- 4.4.1.9 The employer shall record inspection and maintenance dates on the container or on a tag attached to the container.
- 4.4.1.10 The employer shall train employees designated to inspect, maintain, operate, or repair fire extinguishing systems and periodically review their training to keep them up-to-date in the functions they are to perform.
- 4.4.1.11 The employer shall not use chlorobromomethane or carbon tetrachloride as an extinguishing agent.
- 4.4.1.12 The employer shall coat system components installed out of doors or in the presence of corrosive atmospheres to protect them against corrosion.
- 4.4.1.13 Automatic detection equipment shall be approved, installed and maintained in accordance with 4.8.
- 4.4.1.14 The employer shall assure that all systems are designed to operate properly between -7°C and 54°C . Systems designed for and installed in areas with climatic extremes shall also be capable of operation at the expected extreme temperature levels.
- 4.4.1.15 In engineered systems, the employer shall assure that the rate of application of an agent is such that the designed concentration can be reached within 30 seconds of initial discharge.
- 4.4.1.16 In systems using agent concentrations exceeding the maximum safe level for the agent, the employer shall assure that automatic actuation be by means of an approved automatic fire detection device installed and interconnected to an alarm system to ensure the safe egress of employees from the discharge area prior to actuation.
- 4.4.1.17 The employer shall provide at least 1 manual station for discharge activation of fixed extinguishing system .
- 4.4.1.18 The employer shall identify manual operating devices as to the hazard they protect.
- 4.4.1.19 The employer shall provide, and make readily available, the personal protective equipment needed to rescue employees trapped in hazardous atmospheres created by an agent discharge near the protected area.
- 4.4.1.20 The employer shall provide a means of egress from the discharge area in accordance with the Gulf standard mentioned in 2. 1.
- 4.4.2 Total flooding systems with potential health and safety hazards to employees

- 4.4.2.1 The employer shall provide an emergency action plan, in accordance with the Gulf standard mentioned in 2. 1, for each area within a workplace that is protected by a total flooding system which provides agent concentrations exceeding the maximum safe levels set forth in 4.6.
- 4.4.2.2 Those systems installed in areas where employees cannot enter during or after the system operates are exempt from this paragraph.
- 4.4.2.3 The employer shall provide a predischage alarm which will operate at least 30 seconds before the system discharges on all total flooding systems under the scope of this paragraph.
- 4.5 **Fixed Extinguishing System, Dry Chemical**
 - 4.5.1 Specific requirements
 - 4.5.1.1 Dry chemical agents designed to be used in combination with foams or wetting agents shall be approved for such use.
 - 4.5.1.2 The employer shall not mix dry chemicals of different compositions together. Systems designed for use with one chemical shall not be refilled with any other type.
 - 4.5.1.3 When dry chemical discharge may cause visual obscuration, the employer shall provide a predischage alarm for employees to safely egress from the discharge area. The predischage alarm shall activate at least 30 seconds before release of the agent.
 - 4.5.1.4 The employer shall sample the dry chemical supply in all except stored pressure systems from the top center of the supply tank and near the tank wall, at least annually, to determine if lumps exist which are harder than will be easily crumbled or reduced to powder when dropped from a height of 10 cm.
- 4.6 **Fixed Extinguishing Systems, Gaseous Agent**
 - 4.6.1 Specific requirements
 - 4.6.1.1 Agents used for initial supply and replenishment shall be of the type approved for the system's application. Carbon dioxide obtained by dry ice conversion to liquid is not acceptable unless it is processed to remove excess water and oil.
 - 4.6.1.2 The employer shall maintain inerting type gaseous extinguishing concentrations by minimizing leakage from the enclosure or by applying extra gas if necessary.
 - 4.6.1.3 The designed extinguishing concentration for surface fires shall be achieved with a minimum development of toxic decomposition products.
 - 4.6.1.4 The employer shall assure that the designed extinguishing concentration for deep-seated fires is maintained for at least 7 minutes after the initial discharge. It shall also be maintained for a sufficient period of time to allow the smoldering to be extinguished and the material to cool to a point in which reignition will not occur when the inert atmosphere is dissipated.
 - 4.6.1.5 The employer shall provide a maximum discharge time of 30 seconds to reach the design concentration on all gaseous agent systems.

- 4.6.1.6 When fire brigades perform designated emergency actions under the emergency action plan meeting the requirements of the Gulf standard mentioned in 2.1, the employer shall assure that an effective agent concentration be maintained for a sufficient period of time to allow for effective emergency actions.
- 4.6.1.7 The employer shall provide a distinctive pre-action or predischage alarm capable of being preceived above ambient light or noise levels when agent concentrations exceed the maximum safe level for employee exposure. The maximum safe levels for employee exposure without using personal protective equipment are as follows:
- For carbon dioxide, 4 percent: or
- For Halon 1301, 10 percent: or
- For Halon 1211, 4 percent.
- 4.6.1.8 The employer shall not use Halon 1301 in concentrations greater than 10 percent in areas normally occupied by employees unless the protected spaces are to be evacuated by employees immediately after discharge of the agent or sooner. Where egress from an area cannot be accomplished within 1 minute, the employer shall not use Halon 1301 in concentrations greater than 7 percent. Halon 1301 concentrations are permitted greater than 10 percent, but less than 15 percent, in areas not normally occupied by employees provided egress can be accomplished within 30 seconds. Where concentrations can exceed 15 percent, the employer shall prevent employee exposure to the gas.
- 4.6.1.9 The employer shall not use Halon 1211 or carbon dioxide in areas normally occupied by employees except where safe emergency egress can be assured in less than 30 seconds from the time of agent discharge.
- 4.6.1.10 The employer shall base the quantity of inerting type gaseous extinguishing agent required on the total rate of discharge needed to blanket the area or volume protected and the time that the discharge must be maintained to assure complete extinguishment.
- 4.7 Fixed Extinguishing Systems, Water Spray and Foam**
- 4.7.1 Specific Requirements**
- 4.7.1.1 The employer shall not use foams to extinguish fires involving gases, liquified gases with boiling points below ambient workplace temperatures such as butane, butadiene, propane, or cryogenic liquids.
- 4.7.1.2 The employer shall not use foams or water spray to extinguish fires in materials which react violently with water, such as metallic sodium and metallic potassium.
- 4.7.1.3 The employer shall not use regular foams for polar solvent liquids.
- 4.7.1.4 The employer shall not mix different types of foam concentrates because they may be incompatible.
- 4.7.1.5 The employer shall not permit foams, other than alcohol foams, to be discharged through foam spray devices onto fires involving water soluble solvents in depths exceeding 2.5 cm.

- 4.7.1.6 The employer shall assure that water spray systems be designed so that extinguishment or control can be accomplished and so that all necessary surfaces can be cooled sufficiently to prevent “flash back” occurring after the system is shut off.
- 4.7.1.7 The employer shall assure that drainage of water spray systems be directed to locations away from employee work areas.
- 4.8 **Fire Detection Systems**
 - 4.8.1 Installation and Restoration
 - 4.8.1.1 The employer shall assure that all devices, combination of devices, and equipment constructed and installed to comply with this standard be approved for the purpose for which they are intended.
 - 4.8.1.2 The employer shall restore all fire detection systems and components to normal operating condition as promptly as possible after each test or alarm. Spare detection devices and components which are normally destroyed in the process of detecting fires shall be kept stocked in quantities and locations to be available for prompt restoration of the system.
 - 4.8.2 Maintenance and Testing
 - 4.8.2.1 The employer shall maintain all systems in an operable condition.
 - 4.8.2.2 The employer shall test and adjust the sensitivity and reliability of fire detectors and the fire detection system as often as needed to maintain proper operating conditions.
 - 4.8.2.3 The employer shall assure that pneumatic and hydraulic operated detection systems installed be equipped with supervised systems.
 - 4.8.2.4 The employer shall assure that the servicing, maintenance and testing of fire detection systems be performed by a trained person knowledgeable in the operations and functions of the system.
 - 4.8.2.5 The employer shall clean fire detectors that need to be cleaned of dirt, dust or other particulates in order to be fully operational at regular and periodic intervals. The cleaning operation and checking procedure, and necessary sensitivity adjustments shall be done by a trained person knowledgeable in the proper function and servicing of the equipment.
 - 4.8.3 Protection of Fire Detectors
 - 4.8.3.1 The employer shall protect fire detection equipment installed out of doors or in the presence of corrosive atmospheres from corrosion. The employer shall provide detection equipment requiring protection from the weather with a canopy, hood, or other suitable protection.
 - 4.8.3.2 The employer shall locate or otherwise protect detection equipment so that it is protected from mechanical or physical impact.
 - 4.8.3.3 The employer shall support detectors independently of their attachment to wires or tubing.
 - 4.8.4 Response Time

- 4.8.4.1 The employer shall assure that fire detection systems installed primarily for the purpose of actuating fire extinguishment or suppression systems shall be designed to operate in time to control or extinguish a fire.
- 4.8.4.2 The employer shall assure that fire detection systems installed for the purpose of employee alarm and evacuation be designed and installed to allow sufficient time for safe escape of employees.
- 4.8.4.3 The employer shall not delay alarms or devices initiated by fire detector actuation more than 30 seconds unless the actions are not necessary for immediate safety of employees. In such cases the emergency action plan shall assure employees be notified, or extinguishment be actuated, in sufficient time to assure the safety and health of employees.
- 4.8.5 The employer shall assure that the number, spacing and location of fire detectors is based upon design data obtained from field experience or tests, engineering surveys, the manufacturer's recommendations, or recognized testing laboratory listing.
- 4.9 **Employee Alarm Systems**
 - 4.9.1 General
 - 4.9.1.1 The employer shall provide employees with an alarm system which will provide sufficient reaction time to safely escape from a life threatening emergency in the workplace.
 - 4.9.1.2 The employee alarm shall be capable of being perceived above ambient noise or light levels by all employees in the affected portions of the workplace. Tactile devices may be used to alert those employees who would not be otherwise able to recognize the audible or visual alarm.
 - 4.9.1.3 The employee alarm shall be distinctive and recognizable to employees as a signal to perform actions designated under the emergency action plan.
 - 4.9.1.4 The employer shall explain the preferred means of reporting emergencies, such as by manual pull-box alarms or by telephone, to each employee. The employer shall post emergency telephone numbers near telephones, on employee notice boards, and other conspicuous locations.
 - 4.9.2 Installation and Restoration
 - 4.9.2.1 The employer shall ensure that all devices, components, combinations of devices or systems constructed and installed comply with this standard. Steam whistles, air horns, strobe lights or similar fighting devices, or tactile devices meeting the requirements of this subparagraph shall be considered acceptable.
 - 4.9.2.2 The employer shall restore employee alarm systems to normal operating condition as promptly as possible after each test or alarm. The employer shall maintain a stock of the necessary spare alarm devices and components subject to wear or destruction in quantities and locations for prompt restoration.
 - 4.9.3 Maintenance and Testing
 - 4.9.3.1 The employer shall maintain all employee alarm systems in operating condition.

- 4.9.3.2 The employer shall make a test of the reliability and adequacy of the employee alarm system at bi-monthly intervals. A different actuation device shall be used in each test so that no individual device is used for two consecutive tests.
- 4.9.3.3 The employer shall maintain or replace power supplies as often as is necessary to assure a fully operational condition. Back-up means of alarm shall be provided when systems are out of service (i.e., employee runners, telephone, etc).
- 4.9.3.4 The employer shall ensure that employee alarm systems be supervised in such a manner that system failure to remain operational will result in a positive notification to assigned personnel that a deficiency exists in the system.
- 4.9.3.5 The employer shall ensure that the servicing, maintenance and testing of employee alarms be done by persons trained in the designed operation and functions necessary for reliable and safe operation.
- 4.9.4 **Manual Operation**
 - 4.9.4.1 The employer shall ensure that the manually operated pull boxes for use in conjunction with employee alarms be unobstructed, conspicuous and readily accessible. The employees shall not have to travel more than 61 m to reach a manual pull box device or a telephone in the alarm system area.
 - 4.9.4.2 Manual fire alarm pull boxes shall be approved.
- 4.10 **Fire Brigades**
 - 4.10.1 **Organization**
 - 4.10.1.1 The employer shall prepare and maintain a statement or written policy which establishes the existence of a fire brigade and which describes the functions that the fire brigade is to perform at the workplace and it shall be available for inspection by the concerned authority or by employees or their designated representatives.
 - 4.10.1.2 The employer shall ensure that employees who are expected to do interior structural fire fighting are physically capable of performing duties which may be assigned to them during emergencies or other operations. The employer shall not permit employees with known heart disease, epilepsy, or emphysema, to participate in fire brigade emergency activities unless permitted by a certificate from a licensed physician.
 - 4.10.2 **Training**
 - 4.10.2.1 The employer shall provide training commensurate with those functions that the fire brigade is expected to perform.
 - 4.10.2.2 The employer shall ensure that training conducted frequently enough to assure that assigned duties and functions will be performed satisfactorily and in a safe manner so as not to endanger brigade members or other employees. At minimum, training shall be conducted annually.
 - 4.10.2.3 The employer shall ensure that training for members of the fire brigade includes hands-on training, where members operate the equipment which they are expected to use and perform those operations that the brigade members are expected to perform during emergency situations.

- 4.10.2.4 The employer shall inform fire brigade members about special hazards to which they may be exposed during fire and other emergencies. They shall also be advised of any changes that occur in relation to the special hazards. The employer shall develop procedures that describe the actions to be taken in situations involving the special hazards.
- 4.10.3 Firefighting Equipment. The employer shall maintain and periodically inspect firefighting equipment to assure the safe operational condition of the equipment.
- 4.10.4 Protective Clothing. The following requirements apply only to those employees who perform interior structural firefighting.
 - 4.10.4.1 The employer shall ensure that protective clothing meets the requirements contained in this paragraph. The employer shall assure that all brigade members wear it.
 - 4.10.4.2 The employer shall ensure that the protective clothing protects the head, body, and extremities, and consists of at least the following components: foot and leg protection; hand protection; body protection; eye, face and head protection.
 - 4.10.4.3 Foot and leg protection shall be achieved by one of the following methods:
 - 4.10.4.3.1 Fully extended boots which meet the requirements of 4.10.4.4 and which provide protection for the legs.
 - 4.10.4.3.2 Protective shoes or boots which meet the requirements of 4.10.4.4 and which are worn in combination with protective trousers that meet the requirements of 4.10.4.6.
 - 4.10.4.4 Protective footwear shall meet the requirements of Section 5.5 for class 75 footwear. In addition, protective footwear shall be water-resistant for at least 12.7 cm above the bottom of the heel and shall be equipped with slip-resistant outer soles. Protective footwear shall provide protection against penetration of the midsole by a common nail when at least 136 kg of static force is applied to the nail.
 - 4.10.4.5 Body protection shall be coordinated with foot and leg protection to ensure full body protection for the wearer. This shall be achieved by one of the following methods:
 - Wearing of a fire-resistive coat meeting the requirements of this paragraph in combination with fully extended boots meeting the requirements of this paragraph.
 - Wearing of a fire-resistive coat in combination with protective trousers both of which meet the requirements of this paragraph.
 - 4.10.4.6 The performance, construction, and testing of fire-resistive coats and protective trousers may be with the following permissible variations in requirements.
 - 4.10.4.6.1 Liner may be detachable but the shell is not permitted to be worn without the liner while performing interior structural firefighting.
 - 4.10.4.6.2 To achieve increased ventilation of trapped body heat, the outer shell and vapor barrier may be penetrated by ventilation openings protected by non-metallic flame resistant material equal to this standard.
 - 4.10.4.6.3 Tearing strength of the outer shell shall be a minimum of 3.6 kg in any direction.

- 4.10.4.6.4 The criteria for flame resistance of the outer shell, including that of trim, after the removal of the flame shall be:
- Maximum after-flame 2.0 seconds
 - Maximum after-glow 4.0 seconds
 - Average char-length 150 cm.
- 4.10.4.6.5 The outer shell and lining may char or discolor but must retain heat resistance and shall not separate or melt when placed in a forced air laboratory oven at a temperature of 260°C for a period of 5 minutes.
- 4.10.4.7 Hand protection shall consist of protective gloves or glove system which allow dexterity of hand movement and sense of feel for objects.
- 4.10.4.8 Exterior material of protective gloves shall provide resistance against abrasion, puncture, and absorption of liquids.
- 4.10.4.9 Exterior material of gloves shall be fire resistant. Maximum allowable after flame shall be 2.0 seconds and the maximum char length shall be 10.2 cm.
- 4.10.4.10 Protective gloves or glove system shall provide thermal insulation. Thermal insulation shall be sufficient so that the temperature inside the palm and gripping surface of the fingers of the gloves shall not exceed 44°C when gloves or glove system are exposed to 500°C for 5 seconds at 0.3 kg/sq cm pressure.
- 4.10.4.11 When design of the fire-resistive coat does not otherwise provide protection for the wrists, protective gloves shall have wristlets of at least 10.2 cm in length to protect the wrist area when the arms are extended upward and outward from the body.
- 4.10.4.12 Head protection shall consist of a protective head device with ear flaps and chain straps.
- 4.10.4.13 Protective eye and face devices complying with the Gulf standard mentioned in 2.2 shall be used by brigade members when performing operations where the hazards of flying or falling materials are present and which may cause eye and face injuries. Protective eye and face devices provided as accessories to protective head devices (face shields) are permitted when such devices meet the requirements of the Gulf standard mentioned in 2.2.
- 4.10.4.14 Fire brigade members wearing full facepieces of breathing apparatus meeting the requirements of the Gulf standard mentioned in 2.2 and 4.10.5 shall be acceptable as meeting the eye and face protection requirements of this paragraph.
- 4.10.5 Respiratory Protection Devices
- 4.10.5.1 The employer shall assure that respiratory protective devices worn by brigade members meets the requirements contained in the Gulf standard mentioned in 2.2 and the requirements contained in this paragraph.
- 4.10.5.2 Approved self-contained breathing apparatus with full-facepiece shall be worn by brigade members while working inside buildings or confined spaces where there is dense smoke or an oxygen deficiency. Such apparatus shall also be worn during emergency situations involving toxic substances.

- 5.10.5.3 Approved self-contained breathing apparatus shall be acceptable if equipped with a "Buddy breathing" device or a quick disconnect apparatus, or restrict the air flow of the apparatus, or obstruct the normal operation of the apparatus.
- 4.10.5.4 Approved self-contained compressed air breathing apparatus shall be acceptable when used with approved cylinders from other approved self-contained compressed air breathing apparatus when such cylinders are of the same size and pressure rating.
- 4.10.5.5 Self-contained breathing apparatus shall have a minimum service life rating of 30 minutes.
- 4.10.5.6 The employer shall clean and recharge each breathing apparatus after each use. Self-contained breathing apparatus shall be stored in such a manner that it will be maintained in a clean and operable condition.
- 4.10.5.7 Self-contained breathing apparatus shall be provided with an indicator which automatically sounds an audible alarm when the remaining service life of the apparatus is reduced to within a range of 20 to 24 percent of its rated service time.
- 4.10.5.8 The employer shall assure that self-contained breathing apparatus be of the pressure-demand or other positive-pressure type when such apparatus is worn by brigade members while performing interior structural fire fighting operations.
- 4.10.5.9 This requirement does not prohibit the use of a combination type self-contained breathing apparatus where the apparatus can be switched from a demand to a positive-pressure mode. However, such apparatus shall be in the positive-pressure mode when brigade members are performing interior structural fire fighting operations.
- 4.10.5.10 New positive-pressure breathing apparatus, including full-facepiece, shall be capable of performing in temperatures down to 40°C without malfunction or loss of respiratory protection to the wearer for the duration of the equipment.
- 4.11 **Protection at construction site**
 - 4.11.1 General
 - 4.11.1.1 The employer shall be responsible for the development of a fire protection program to be followed throughout all phases of the construction and demolition work, and he shall provide for the firefighting equipment as specified herein. As fire hazards occur, there shall be no delay in providing the necessary equipment for fire control.
 - 4.11.1.2 Access to all available firefighting equipment shall be maintained at all times.
 - 4.11.1.3 Wherever there is no off site local fire protection available, the employer shall provide a trained and equipped firefighting organization (Fire Brigade) to assure protection to life.
 - 4.11.1.4 A temporary or permanent water supply, of sufficient volume, duration, and pressure, required to operate the firefighting equipment shall be made available as soon as combustible materials accumulate in a quantity sufficient to cause a life threatening fire.

- 4.11.1.5 Where underground water mains are to be provided, they shall be installed, completed, and made available for use as soon as a life threatening fire is possible.
- 4.11.2 Fire Extinguishers and Small Hose
 - 4.11.2.1 Travel distance from any point of the protected area to the nearest fire extinguisher shall not exceed 30 m.
 - 4.11.2.2 A 13 mm diameter garden-type hose line, not to exceed 30 m in length and equipped with a nozzle, may be substituted for a fire extinguisher, provided that it is capable of discharging a minimum of 19 liters/min. with a minimum hose stream range of 9 m horizontally. The garden-type hose lines shall be mounted on conventional racks or reels. The number and location of hose racks or reels shall be such that at least one hose stream can be applied to all points in the area.
 - 4.11.2.3 One or more fire extinguishers shall be provided on each floor. In multi-story buildings or structures, at least one fire extinguisher shall be located adjacent to stairway.
 - 4.11.2.4 Extinguishers subject to freezing shall be protected from freezing.
 - 4.11.2.5 A B rated fire extinguishers shall be provided within 15 m of wherever more than 19 liters of flammable or combustible liquids or 2.3 kg of flammable gas are being used on the jobsite. This requirement does not apply to the integral fuel tanks on motor vehicles.
 - 4.11.2.6 Carbon tetrachloride and other toxic vaporizing liquid fire extinguishers are prohibited.
 - 4.11.2.7 Only fire extinguishers which have been approved by the concerned authority shall be used.
 - 4.11.2.8 Thirty metres or less of 3.8 cm hose, with a nozzle capable of discharging water at 95 liters/min. or more, may be substituted for a fire extinguisher in the designated area provided that the hose line can reach all points in the area.
 - 4.11.2.9 If fire hose connections are not compatible with local firefighting equipment, the contractor shall provide adapters or equivalent to permit connections.
 - 4.11.2.10 During demolition involving combustible materials, charged hose lines supplied by hydrants, water tank trucks with pumps, or equivalent, shall be made available.
- 4.11.3 Sprinkler Protection
 - 4.11.3.1 If the facility being constructed includes the installation of automatic sprinkler protection, the installation shall closely follow the construction and shall be placed in service as soon as applicable laws permit following completion of each story.
 - 4.11.3.2 During demolition or alterations, existing automatic sprinkler installations shall be retained in service as long as reasonable. The operation of sprinkler control valves shall be permitted only by properly authorized persons. Modification of sprinkler systems to permit alterations or additions or additional demolition should be expedited so that the automatic protection may be returned to service as quickly as possible. Sprinkler control valves shall be checked daily at close of work to ascertain that the protection is in service.

- 4.11.3.3 In all structures in which standpipes are required, or where standpipes exist in structures being altered, they shall be operational as soon as applicable laws permit, and shall be maintained as construction progresses in such a manner that they are always ready for fire protection use. The standpipes shall be provided with Siamese fire department connections on the outside of the structure, at the street level, which shall be conspicuously marked.
- 4.11.3.4 An alarm system, for example, telephone system, siren, etc, shall be established by the employer whereby employees on the site and the local fire brigade can be alerted for an emergency.
- 4.11.3.5 The alarm code and reporting instructions shall be conspicuously posted at phones and at employee entrances.
- 4.11.3.6 Fire walls and exit stairways, required for the completed buildings or structure, shall be given construction priority. Fire doors, with automatic closing devices, shall be hung on openings as soon as practicable.
- 4.11.3.7 Fire cutoffs shall be retained in buildings undergoing alterations or demolition until operations necessitate their removal.
- 4.11.4 Prevention at Construction Site
 - 4.11.4.1 General
 - 4.11.4.1.1 Internal combustion engine powered equipment shall be so located that the exhausts escape away from combustible materials. When the exhausts are piped to outside the building under construction, a clearance of at least 15 cm shall be maintained between such piping and combustible materials.
 - 4.11.4.1.2 Smoking shall be prohibited at or in the vicinity of operations which constitute a fire hazard, and a sign shall be conspicuously posted: "No Smoking or Open Flame".
 - 4.11.4.1.3 Portable battery powered lighting equipment, used in connection with the storage, handling, or use of flammable gases or liquids, shall be of the type approved for the hazards locations.
 - 4.11.4.1.4 The nozzles of air, inert gas, and steam lines or hoses, when used in the cleaning or ventilating of tanks and vessels that contain hazardous concentration of flammable gases or vapors, shall be bonded to the tank or vessel shell. Bonding devices shall not be attached or detached in places containing hazardous concentrations of flammable gases or vapors.
 - 4.11.4.1.5 No temporary building shall be erected where it will adversely affect any means of exit. Temporary buildings, when located within another building or structure shall be of either noncombustible construction or of combustible construction having a fire resistance of not less than one hour.
 - 4.11.4.1.6 Temporary buildings, located other than inside another building and not used for the storage, handling, or use of flammable or combustible liquids, flammable gases, explosives, or blasting agents, or similar hazardous occupancies, shall be located at a distance of not less than 3 m from another building or structure. Groups of temporary buildings, not exceeding 186 sq m in aggregate, shall, for the purpose of this part, be considered a single temporary building.

- 4.11.4.1.7 Driveways between and around combustible storage piles shall be at least 4.6 m wide and maintained free from accumulation of rubbish, equipment, or other articles or materials. Driveways shall be so spaced that a maximum grid system unit of 15 m by 46 m is produced.
- 4.11.4.1.8 The entire storage site shall be kept free from accumulation of unnecessary combustible materials. Weeds and grass shall be kept down and a regular procedure provided for the periodic cleanup of the entire area.
- 4.11.4.1.9 When there is a danger of an underground fire, that land shall not be used for combustible or flammable storage.
- 4.11.4.1.10 Portable fire extinguishing equipment, suitable for the fire hazard involved, shall be provided at convenient, conspicuously accessible locations in the yard area. Portable fire extinguishers shall be placed so that maximum travel distance to the nearest unit shall not exceed 30 m.
- 4.11.4.2 Indoor Storage
 - 4.11.4.2.1 Storage shall not obstruct, or adversely affect, means of exit.
 - 4.11.4.2.2 Noncompatible materials, (oxygen and oil) which may create a fire hazard, shall be segregated by a barrier having a fire resistance of at least 1 hour.
 - 4.11.4.2.3 Material shall be piled to minimize the spread of fire internally and to permit convenient access for firefighting. Stable storage heights shall be maintained at all times. Aisle space shall be maintained to safely accommodate the widest vehicle that may be used within the building for firefighting purposes.
 - 4.11.4.2.4 Clearance shall be maintained around lights and heating units to prevent ignition of combustible materials.
 - 4.11.4.2.5 A clearance of 61 cm shall be maintained around the path of travel of fire doors unless a barricade is provided, in which case no clearance is needed. Materials shall not be stored within 1 m of a fire door opening.

APPENDIX A

1. PORTABLE FIRE EXTINGUISHERS**A. Mounting**

Portable fire extinguishers may be mounted on hooks, brackets, or other devices provided the device will adequately support the extinguisher. Extinguishers should be mounted at a height where employees can remove them from their mounting device without injury. In cases where extinguishers can be struck by moving vehicles such as fork lift trucks, elevating mounting boards may be used to lift the extinguisher up to a safe height provided the extinguisher can be lowered and ready for use within 1 minute.

B. Selection and Distribution

- 1) Selection. Extinguishers for protecting Class A hazards may be selected from the following types: Water, foam, loaded stream or multi purpose dry chemical. Extinguishers for class B hazards may be selected from the following types: Halon 1301, Halon 1211, carbon dioxide, dry chemicals, foam, or loaded stream. Extinguishers for Class C hazards may be selected from the following types: Halon 1301, Halon 1211, carbon dioxide, or dry chemical. Class D fire hazards pose a problem in that there are few approved agents available in the marketplace. Whatever agents are available they are generally limited to one or a single class of metal hazard. In cases when an approved agent is unavailable for a specific workplace Class D hazard, the following alternative agents are recommended for general use.

- a. Foundry flux,
- b. Graphite powder,
- c. Dry sand,
- d. Dry dolomite, and
- e. Dry talc, (powder).

The above listed agents have the ability to control if not extinguish many Class D fires found in most industrial operations. Because water can increase the severity of a Class D fire, these agents must be kept dry. Additional agents can be found by referring to any general fire protection engineering publication. When the employer selects the types of extinguishers for use against other than Class D hazards, he should make sure that the extinguisher has been approved.

In the selection of an extinguisher, the employer should give consideration to the health and safety hazards involved in the maintenance and use of the unit. Bromotrifluoromethane (Halon 1301) and bromochlorodifluoromethane (Halon 1211) extinguishers contain extinguishing agents whose vapor has a low toxicity. However, their decomposition products can be more hazardous. Employees should be

instructed about the hazards of breathing the decomposition vapors. Dry chemical extinguishers used in small unventilated work areas may reduce visibility for up to several minutes.

- 2) Distribution. The following tables give recommended distribution Patterns for Class A and Class B fire extinguishers:

CLASS A HAZARDS

	Hazard Classification		
	Low	Ordinary	High
Minimum extinguisher rating	1A	2A	3A
Maximum floor area/unit of A	279 sq m	139 sq m	93 sq m
Maximum floor area/extinguisher	1045 sq m	1045 sq m	1045 sq m
Maximum travel distances	23 m	23 m	23 m

CLASS A HAZARDS

	Hazard Classification		
	Low	Ordinary	High
Basic minimum rating	5B/10B	10B/20B	20B/40B
Maximum travel distance	9m/15m	9m/15m	9m/15m

Even though these tables are recognized as being an acceptable means for compliance, they do not preclude other distributions which can be shown to provide for adequate employee life safety: alternative distribution is acceptable. For example, where an employer provides an employee fire brigade as permitted in 4. 1, portable equipment can be installed on special trucks or in special storage areas known to the fire brigade. Distribution patterns for Class C hazards should be based upon the Class B patterns. Distribution of Class D extinguishers should be based upon the 23 m travel distance.

C. Inspection. Maintenance and Testing

A reputable fire equipment servicing agency is usually the most reliable means available to the employer for having maintenance and recharging performed. Larger employers may find it desirable to establish their own maintenance and recharge facilities and train employees to perform these functions. In such cases the service manuals and parts, lists for the equipment should be obtained from the extinguisher manufacturer. Any employer who inspects, maintains or tests portable fire extinguishers should become familiar with the methods and equipment recommended in the references in Appendix C.

2. STANDPIPE AND HOSE SYSTEMS

A. Pre-fire Planning

It is suggested that a pre-fire plan be coordinated with the local fire brigade. Such a plan would eliminate the unnecessary handling of hose by arriving fire departments. It would also assure that hose couplings used by the plant and the local fire brigade would be compatible.

D. Protection of Standpipes

Standpipes may be protected by guards such as expanded metal cages, enclosure in walls, or bumper poles. Standpipes are considered damaged when they have been punctured or ruptured, creased or dented enough to restrict water flow, or have had components such as valves, valve wheels or handles or other devices removed or broken.

C. Equipment

- 1) Hose should be considered unserviceable when it is visually inspected and found to be punctured, rotted, mildewed, or similarly damaged. Other standpipe and hose system equipment should be considered unserviceable when it is no longer capable of providing the service for which it was approved.
- 2) Hemp or linen hose can become damaged if it is not properly dried after use. If this hose is stored in a damp or wet condition, it will deteriorate.
- 3) Spray-type nozzles provide more effective fire control than straight-stream types. Solid stream nozzles may contribute to the spread of a fire by scattering burning materials. Employers should assure that employees are aware of the type of nozzles used on workplace hose systems.
- 4) Standardized hose coupling screw threads are necessary to provide effective use of fire hose provided by different fire brigades. However, certain geographical areas of the country have adopted other standard threads. The employer is encouraged to check with local supporting fire departments to determine what thread is used so that equipment purchased for use in the workplace can be compatible.

3. AUTOMATIC SPRINKLER SYSTEMS

A. Design and Installation

Automatic sprinkler systems should be designed by professionals trained in the use of pipe schedules or hydraulic design principles. A reputable sprinkler installation firm can determine the necessary discharge patterns, densities and water flow characteristics for adequate employee safety and should be contracted for such work. Many workplaces contain automatic sprinkler systems which were designed and installed many years ago in accordance with standards in effect at that time. These systems are acceptable for the purposes of this paragraph, if there

is an adequate water supply, piping system, and sprinkler pattern available to assure employee safety.

B. Maintenance

Back-up protection for automatic sprinkler systems being repaired may be provided in the affected areas by hose lines, portable extinguishers, partial evacuations, fire watches, or similar preventive measures.

Sprinkler system valves and devices can be protected from damage by enclosing them in cage-type guards or by placing protective barriers around them.

The employer is encouraged to provide a supply of spare sprinklers, of the type used on each system, near the sprinkler valve.

Employers are encouraged to install supervisory control systems on sprinkler systems to alert them of closed valves, loss of air pressure on dry pipe systems or other malfunctions which may affect employee safety.

Auxiliary water supplies include fire department connections, gravity tanks, pumps and cistern or pond, or a pressure tank.

D. Protection of Piping

System piping can be protected from freezing by using dry pipe systems in unheated areas. Heating protected areas or insulating piping can protect wet pipe systems from freezing. System piping can be protected for exterior surface corrosion by coating with paint or other coating. Approved corrosion resistant sprinklers are available. Fusible links on sprinklers should not be painted because it reduces their effectiveness.

E. Sprinkler spacing

The employer should use the services provided by professional sprinkler system designers to determine what spacings and clearances are necessary to provide maximum protection.

4. FIXED EXTINGUISHING SYSTEMS, GENERAL

A. Design

Fixed extinguishing systems are permanent in their location and installation. They use any of several agents such as dry chemical, foam, water spray, Halon 1211, or Halon 1301. They can be designed for local or total flooding applications. They can be of a customized design for a specific hazard or of a pre-engineered design for more standardized hazard applications.

When the employer selects a fixed extinguishing system to meet a requirement, the selection should be based on the requirement and following factors:

- 1) Size and class of hazard.
- 2) Employee exposure to the hazard and the agent.
- 3) Employee safety and health considerations associated with the agent. (See specific agent section).

B. Employees safety

Warning or hazard signs should be posted so that they can be read from a distance of 3 m or more. For those reasons where employees may be trapped due to total flooding systems, the employer is encouraged to provide escape self-contained breathing apparatus of at least 5 minute service life in such areas.

C. Maintenance

Employers are encouraged to conduct an acceptance test on all new systems to assure that piping and valves are properly connected. Employers should install supervisory control system on all major operated valves to better assure the systems are ready for use.

5. FIXED EXTINGUISHING SYSTEMS, DRY CHEMICALS**A. Design and Installation**

The dry chemical systems described in 4.5 are designed to discharge a dry chemical from fixed nozzles and piping, or from hose lines by means of an expellant gas. The intent of the standard is to present the design considerations applicable to those systems.

Employers are encouraged to perform acceptance tests on new dry chemical systems by discharging the expellant gas and checking for major gas leaks in the piping and valves.

B. Hazards to Employees

Dry chemical fire extinguishing agents are considered nontoxic. However, as with any finely divided material, they may produce mild irritation effects especially when used in an enclosed area. In general, these effects are neither serious nor permanent. For more specific guidance or individual dry chemical extinguishing agent components and their hazards to personnel, the dry chemical manufacturer should be consulted.

6. FIXED EXTINGUISHING SYSTEMS, GASEOUS AGENTS**A. Carbon Dioxide**

- 1) The Agent: As a fire extinguishing agent, carbon dioxide has a number of desirable properties. It is noncorrosive and leaves no residue to clean up after a fire. Since it is a gas, it will penetrate and spread to all parts of a hazard. It will not conduct electricity and may therefore be used on live electrical hazards. It may be effectively used on practically all combustible materials, except for a few reactive metals and metal hydrides and materials such as cellulose nitrate, which contain available oxygen. Under normal conditions carbon dioxide is an odorless, colorless gas with a density about 50 percent greater than the density of air. Many insist that they can detect an odor of carbon dioxide, but this may be due to impurities or chemical effects in the nostrils.

- 2) **Toxicity:** Although carbon dioxide is only mildly toxic, it will definitely produce unconsciousness and death when present in fire extinguishing concentrations. The action in this case is related to suffocation more than to any toxic effect of the carbon dioxide itself. It has been determined by test that atmospheres containing 3 or 4 percent carbon dioxide will cause one to breathe rapidly, but will otherwise have no important effect for relatively short exposures. A concentration of about 9 percent almost all people can withstand without losing consciousness within a few minutes. At concentrations above 9 percent, personnel would quickly lose consciousness. At concentrations of about 20 percent, death would follow in about 20 to 30 minutes unless the victim was removed to fresh air. Recovery by artificial respiration is usually rapid because of the natural tendency of carbon dioxide to promote breathing. Aside from the normal effect of carbon dioxide causing unconsciousness, it should be noted that, even before this happens, there may be a marked inability to think clearly and to take prompt action. This effect is important because inexperienced personnel may fail to take proper action if suddenly exposed to relatively high concentrations of carbon dioxide.
- 3) **Employee Hazards:** In most cases the actual hazards to personnel are rather slight. The hazard will be greater where the enclosure is large and where carbon dioxide may enter unsuspected areas such as pits or basements. The difficulty of escaping from a given location, and the possibility of reduced visibility because of a discharge of carbon dioxide may also be important factors. In any case, the extent and type of warning to personnel must be designed to meet the particular requirements of each situation.
- 4) **Employee Safeguards:** The steps and safeguards necessary to prevent injury or death to personnel in atmospheres made hazardous by the discharge of carbon dioxide may include the following:
 - a. Provision for adequate aiseways and routes of exits and keeping them clear at all times.
 - b. Provision for the necessary additional emergency lighting and directional signs to ensure quick and safe evacuation.
 - c. Provision for alarms within such areas that will operate immediately upon detection of the fire, with the discharge of the carbon dioxide and the activation of automatic door closures, delayed for sufficient time, to evacuate the area before discharge begins.
 - d. Provisions for outward swinging self-closing doors at exits from hazard areas, and, where such doors are latched, provision for panic hardware.
 - e. Provision for continuous alarms at entrances to such areas until the atmosphere has been restored to normal.
 - f. Provision for adding an odor to the carbon dioxide so that hazardous atmospheres in such areas can be recognized.

- g. Provision for warning and instruction signs at entrances to and inside of such areas.
 - h. Provision for prompt discovery and rescue of persons rendered unconscious in such areas. This may be accomplished by having such areas searched (immediately after carbon dioxide discharge ceases) by trained employees equipped with proper self-contained breathing apparatus. Self-contained breathing apparatus and personnel trained on its use, and in rescue practices, including artificial respiration, should be readily available.
 - i. Provision for instructions and drills for all personnel within, or in the vicinity of, such areas, including maintenance personnel who may be brought into the area to ensure the correct actions when carbon dioxide protective equipment operates.
 - j. Provision for means for prompt ventilation. Care should be taken to readily dissipate hazardous atmosphere and not merely move them to another location.
- 5) Acceptance Tests. Employers are encouraged to have an acceptance test performed on all new systems to assure that all components of the system will operate properly.

B. Bromotrifluoromethane (Halon 1301)

- 1) The Agent. Halon 1301 is a halogenated compound. Discharge of the agent may create a light mist in the vicinity of the discharge nozzle, resulting from condensation of moisture in the air, but the mist rarely persists after discharge is completed. Thus, little hazard is created from the standpoint of reduced visibility.
- 2) Toxicity. The discharge of Halon 1301 to extinguish a fire may create a hazard to personnel from the compound and from the products of decomposition that result from exposure of the agent to fire or other hot surfaces. Exposure to Halon 1301 is generally of less concern than exposure to the decomposition products. However, unnecessary exposure of personnel to either the Halon 1301 or to the decomposition products should be avoided under decomposed Halon 1301 has been studied in humans and found to produce minimal, if any, central nervous system effects at concentrations below 7 percent for exposures of approximately 5 minutes duration. At concentrations of 7 to 10 percent effects such as dizziness, impaired coordination, and reduced mental activity become definite with exposures of a few minutes duration: however, these effects are not incapacitating for exposures of one minute or less. At concentrations above 10 percent, these effects increase in intensity and may become incapacitating with exposures longer than one minute. At concentrations of 15 to 20 percent, there is the risk of unconsciousness and possibly death if the exposure is prolonged. Personnel should not attempt to remain in an area following discharge of Halon 1301 in concentrations above 7 percent. It is recommended that they do not remain in an area for more than 4 or 5 minutes even though agent concentrations are below 7 percent. Within the first 30 seconds of exposure

to Halon 1301 little effect is noticed even when concentrations of 10 to 15 percent are inhaled. At these levels, this amount of time appears necessary for the body to absorb a sufficient quantity of the agent to bring about the onset of effects. However, at higher concentrations, the onset of symptoms may occur within a few seconds and since an individual may be quickly incapacitated by these higher levels, concentrations greater than 15 percent should not be used where there is any chance of human exposure. The effects of exposure to Halon 1301 may persist for, a short period of time following exposure. However, recovery may be expected to be rapid and complete. Halon 1301 would not be expected to accumulate in the body even with repeated exposures. Anyone suffering from the toxic effects of Halon 1301 vapors should immediately move or be moved to fresh air. In treating persons suffering toxic effects due to exposure to this agent, the use of epinephrine adrenaline and similar drugs must be avoided because they may produce cardiac arrhythmias, including ventricular fibrillation.

- 3) Employee Safeguards. The steps and safeguards necessary to prevent injury or death to personnel in atmospheres made hazardous by the discharge or thermal decomposition of Halon 1301 are the same as those for carbon dioxide described earlier.
- 4) Acceptance Tests. The employer is encouraged to have acceptance tests performed on all new systems to assure that the system will function properly.

C. Bromochlorodifluoromethane (Halon 1211)

- 1) The Agent. Halon 1211 is a colorless gas with a faintly sweet smell and having a density about 5 times that of air. The fire extinguishing characteristics are similar to those of Halon 1301, and reference should be made to that discussion for information.
- 2) Toxicity. The hazards to employees from the discharge of Halon 1211 are also similar to those of Halon 1301, but because of the differences in concentrations, the following is presented. Exposure to Halon 1211 and its products of decomposition may be hazardous. Halon 1211 has been studied in humans and found to produce minimal, if any, central nervous system effects at concentrations below 4 percent for exposures of approximately one minute duration. At concentrations above 4 percent, effects such as dizziness, impaired coordination and reduced mental activity become definite with exposure of a few minutes duration. However, these effects are not incapacitating for exposure of one minute or less. Within the first 30 seconds of exposure to Halon 1211, little effect is noticed, even when concentrations above 4 percent are inhaled. At these levels 30 seconds appears to be the time necessary for the body to absorb a sufficient quantity of agent to bring about the onset of effects. At concentrations on the order of 5 to 10 percent, there is the risk of unconsciousness and possible death if the exposure is prolonged. The effects of exposure of Halon 1211 may persist for a short period of time following exposure. However, recovery may be expected to be rapid and complete. Halon 1211 would not be expected to accumulate in the body even with repeated exposures. The

decomposition products of Halon 1211 are the same as Halon 1301 with the addition of some chlorine compounds and acids (HCl, Cl_2 and COCl_2).

- 3) Employee Safeguards. The safety steps and safeguards for Halon 1211 are the same as those for Halon 1301 and carbon dioxide. Employers are encouraged to have acceptance tests performed on all new systems to assure that the system is ready for use.

7. FIXED EXTINGUISHING SYSTEMS WATER SPRAY AND FOAM AGENTS

A. The Agent

Foam for fire protection purposes is an aggregate of air-filled bubbles formed from aqueous solutions and is lower in density than the lightest flammable liquids. It is used to form a coherent floating blanket on flammable and combustible liquids lighter than water and prevents or extinguishes fire by excluding air and cooling the fuel. It also prevents reignition by suppressing formation of flammable vapors. It has the property of adhering to surfaces, providing a degree of exposure protection from adjacent fires.

B. Toxicity

Generally, foams do not present a toxic hazard when used as a fire extinguishing agent.

C. Employee Hazards

A space filled with high expansion foam is normally not toxic to persons who may be trapped in the space, since the air entrained in the foam is generally not contaminated. However, because of the foam bubbles, some difficulty may be experienced in breathing. Additionally, there is the possibility of the loss of vision and disorientation in the atmosphere of high expansion foam. Because of the potential presence of life safety and injury hazards, entering a foam-filled space should be avoided. When necessary, a coarse water spray may be used to "Cut" a path in the foam and personnel should wear self-contained breathing apparatus and a lifeline when entering an area filled with foam.

D. Storage Considerations

Since all air foam concentrates are water solutions of organic and inorganic chemicals of one type or another, they must be carefully observed for changes in constitution and characteristics. Their storage in shipping containers and in storage tanks must be carried out according to the manufacturer's recommendations. Exposure to extreme heat, cold, contamination, or mixing with other materials must be avoided. Sedimentation or precipitate formation on containers or tanks of concentrate should be carefully checked periodically. The manufacturer or his representative is best qualified to test and determine the extent of reliability of foam concentrates under questionable conditions of deterioration of these liquids.

E. Acceptance Tests

Employers are encouraged to have acceptance tests performed on all new systems to assure that the system will function properly.

F. Drainage

Drainage may be provided with pipe Systems above or below ground, curbing, trenches, or ditches. The drainage should carry any overflowing liquids to a safe place away from employees.

8. FIRE DETECTION SYSTEMS**A. Mounting**

- 1) Locations. Areas where fire detectors should be mounted include: rooms, halls, storage areas, basements, attics, lofts, spaces above suspended ceilings, inside of closets, elevator shafts, enclosed stairwells, dumbwaiter shafts, chutes, and return air ducts on ventilation systems. Other locations may be necessary depending upon workplace hazards.
- 2) Ceilings. Consideration should be given to ceiling configurations when mounting detectors. Heat and smoke will rise to the highest point inside of a workplace; however, a detector will ordinarily operate sooner if it is nearer to a potential fire source. Generally, height is the most important single dimension where ceilings exceed 4.9 m.
- 3) Spacing. Detectors should be spaced in accordance with the manufacturer's recommendations. Reduction of listed spacing may be required for any of the following purposes:
 - a. Need for faster response.
 - b. Need for small fire response.
 - c. Need to accommodate room geometry.
 - d. Need to consider air movement, ceilings or other obstructions.

9. EMPLOYEE ALARM SYSTEMS**A. Purpose**

Employee alarm systems are not necessarily the typical fire alarm pull box interconnected with an alarm gong, bell or horn. In some places the alarm systems may contain a steam whistle, air horns, flashing lights, verbal instructions given either directly or by means of a public address system or a similar means of indicating an emergency. This system may be used to signal not only a fire but also an approaching storm hazard or a geo-physical hazard such as an earthquake or flood. As long as the signal is recognized by the employees as one indicating a life safety hazard, the system may be multi-purpose.

B. Testing

Pull boxes, detectors or other actuating devices may be an integral part of an alarm system. Every actuating device on an alarm system should be tested on a rotational basis to assure their operability. Manufacturer or listing agency recommendations give safe procedures for testing detectors and pull boxes.

C. Alarm Signals

Employers are encouraged to develop distinctive signals for each anticipated emergency. A single bell, horn or light signal for every emergency can lead to confusion and misinterpretation of the alarm. One ring, two rings, one long and one short ring, or something similar for each emergency is an effective method of notifying employees that a specific emergency exists.

10. FIRE BRIGADES**A. Pre-fire Planning.**

It is suggested that the local fire brigade or fire prevention bureau be consulted for additional information which may be helpful in understanding and in the implementation of this paragraph.

A pre-fire plan of the workplace by the local fire brigade in conjunction with the fire brigade is encouraged. This will also be valuable for the local fire brigade in becoming familiar with the workplace and its activities.

B. Organizational Statement.

The organizational statement should include at least the following information: The purpose for which the brigade was organized; intended size of the brigade; number of hours brigade members are to work in relation to brigade functions; type and frequency of training; and duties which are to be performed by brigade members.

C. Physical Qualifications

Physical qualifications can be determined by such methods as preplacement physical examinations, physical agility tests, and periodic physical re-examination while the employee is a member of the brigade. Employees with coronary or respiratory illnesses should not serve as brigade members performing emergency operations unless permitted by a doctor's certificate.

It is also recommended that brigade members participate in a physical fitness program. There are many benefits which can be attributed to being physically fit. It is believed that physical fitness may help to reduce the number of sprain and strain injuries as well as contributing to the improvement of the cardiovascular system.

D. Training

The paragraph on training does not contain specific training requirements because the type, amount, and frequency of training will be as varied as the purposes for which brigades are organized.

However, it is obvious that brigade members who are expected to perform interior structural firefighting should require training which is more comprehensive and more frequent than those brigade members who are only expected to control or extinguish fires in the incipient stage.

The following recommendations should not be considered to be all of the necessary elements for a complete comprehensive training program; but, the

information may be helpful as a guide in developing a fire brigade training program.

All brigade members should be familiar with exit facilities, location and emergency escape routes for handicapped workers and the workplace "Emergency Action Plan".

In addition, brigade members who are expected to control and extinguish fires in the incipient stage should, at a minimum, be trained in the use of fire extinguishers, standpipes, and other fire equipment they are assigned to use. They should also be aware of first-aid medical procedures and procedures for dealing with special hazards to which they may be exposed. Training should include both classroom instruction and actual operation of the equipment under simulated emergency conditions. This type of training should be conducted at least annually but some functions should be reviewed more often.

In addition to the above training brigade members who are expected to perform emergency rescue and interior structural fire fighting should, at a minimum, be familiar with the proper techniques in rescue and fire suppression procedures. Training should include fire protection courses, classroom training, simulated fire situations including "Wet Drills" and, when feasible, extinguishment of actual mock fires. Frequency of training should be at least monthly, but some drills or classroom training should be conducted as often as weekly to maintain the proficiency of brigade members.

E. Protective Clothing

- 1) General. Item 4.10.4 does not require all brigade members to wear protective clothing. It is not the intention of these standards to require employers to provide a full ensemble of protective clothing for every brigade member without consideration given to the types of hazardous environments to which the brigade member may be exposed. It is the intention of these standards to require adequate protection for those brigade members who may be exposed to fires in an advanced stage, smoke, toxic gases, and high temperatures.

Therefore, the protective clothing requirements only apply to those brigade members who are performing interior structural fire fighting operations.

Additionally, the protective clothing requirements do not apply to the protective clothing worn during outside fire fighting operations, crash crew operations, or other special fire fighting activities.

- 2) Foot and Leg Protection. Item 4.10 permits an option to achieve foot and leg protection.

The section recognizes the interdependence of protective clothing to cover one or more parts of the body. Therefore, the option is given so that brigade members may meet the foot and leg requirements by either wearing long fire-resistive coats in combination with fully extended boots; or, by wearing shorter fire-resistive coats in combination with protection trousers and protective shoes or shorter boots.

- 3) Body Protection. Item 4.10.4.6 provides an option for brigade members to 'achieve body protection. Brigade members may wear a fire-resistive coat in combination with fully extended boots; or, they may wear a fire-resistive coat in combination with protective trousers.
- 4) Hand Protection. The requirements of the subparagraph on hand protection may be met by protective gloves or a glove system. A glove system consists of a combination of gloves. The usual components of a glove system consists of a pair of gloves, which provide thermal insulation to the hands, worn in combination with a second pair of gloves which provide protection against fire, abrasion, puncture, and absorption of liquids.
- 5) Head, Eye, and Face Protection. The subparagraph of the standard concerning head protection requires ear flaps to be provided with the protective hand device so that they will be available if needed. It is recommended that ear protection always be used while fighting interior structural fires.

Many head protective devices are equipped with face shields to protect the eyes and face. These face shields are permissible as meeting the eye and face protection requirements of this subparagraph as long as such face shields meet the requirements of the Gulf standard mentioned in 2.2.

Additionally, full facepieces of breathing apparatus meeting the requirements of the Gulf standard mentioned in 2.2 and the requirements mentioned in 4.10.5 therein, are also acceptable as meeting the eye and face protection requirements.

- 6) Respiratory Protective Devices: Since brigade members may be exposed to smoke and toxic substances while Performing interior structural firefighting operations, it is imperative to assure maximum protection against facepiece leakage.

The use of a combination type self-contained breathing apparatus where the apparatus can be switched from a demand to a positive-pressure mode is also acceptable as long as the apparatus is in the positive pressure mode when performing interior structural fire fighting operations. Also acceptable are approved respiratory protective devices which have been converted to the positive-pressure type when such modification is accomplished by competent persons using kits or parts approved and provided by the manufacturer and by following the manufacturer's instructions.

The employer is encouraged to provide brigade members with an alternative means of respiratory protection to be used for emergency escape purposes if the self-contained breathing apparatus becomes inoperative.

Alternative means of respiratory protection may be either a buddy-breathing device or an escape self-contained breathing apparatus (ESCBA). The ESCBA is a short-duration respiratory protective device which is approved only for emergency escape purposes.

It is suggested that if ESCBA units are used, they shall be of at least 5 minutes service life.

4.12 Fire Walls and Doors

- 4.12.1 Rating. The fire-resistance rating of a required fire wall or door assembly shall be not less than specified in these standards.
- 4.12.2 Fire Walls, Combustible Members Projecting Into. The distance between the ends and sides of combustible structural members or other combustible members projecting into a fire wall and the opposite side of the fire wall shall be equal to the wall thickness required to maintain the designated fire-resistance rating. The ends of combustible structural members projecting into fire walls shall be fire cut so that the top of the member projects not more than 2.5 cm into the wall.
- 4.12.3 Fire Walls, Materials, Strength, and Stability. Fire walls shall have fire-resistance ratings as established through a GSMO recognized testing laboratory and shall also comply with the following requirements.
- 4.12.3.1 Materials for Fire Walls. Fire walls shall be constructed of masonry consisting of solid or hollow masonry units laid in mortar of a type necessary to produce the required fire resistance, strength, and stability, or be constructed of concrete or other noncombustible material suitable for the purpose.
- 4.12.3.2 Strength and Stability of Fire Walls. Fire walls shall conform as to strength and stability with an accepted building code which has been adopted by any governmental unit of the Kingdom provided the pertinent provisions of such building code have been approved as providing for adequate strength and stability for fire walls, or exterior bearing walls composed of the same type of materials. A fire wall which requires lateral support to supplement and ensure its stability, shall be so designed and constructed that the structure on any one side could be removed without jeopardizing the structural stability of the fire wall.
- 4.12.4 Fire Walls, Offset. When a fire wall is offset, the offset floor construction and the fire wall supports shall be constructed of noncombustible materials having a fire-resistance rating of not less than that required for the fire wall.
- 4.12.5 Fire Walls, Termination. Fire walls are required to terminate as follows:
- 4.12.5.1 Where the roof construction is noncombustible, fire walls shall be built up tightly against the roof decking or extend above the roof:
- 4.12.5.2 When the roof construction is combustible, fire walls required to have a fire-resistance rating shall extend not less than 80 cm above the adjacent roof surface.
- 4.12.6 Fire Walls, Parapets. Parapets for fire walls shall be of the height required and mentioned in 4.12.5 and shall be of weather-resistant materials. The top of parapets when subject to moisture penetration shall be provided with a coping of noncombustible weatherproofing material with all joints constructed to prevent the penetration of moisture.

Parapets for fire walls shall have a fire-resistance rating of not less than that for the fire wall below, and when constructed of masonry, the thickness of such parapets shall be not less than one-fourth of their height above the roof level, except that when reinforced, the thickness of such parapet walls need not be thicker than that required for strength, stability, and fire-resistance.

- 4.12.7 Fire Walls, Chases and Recesses. Chases or recesses that would, when the work is completed, reduce the fire resistance, strength, or stability of a fire walls to less than that required, shall not be built or cut in a fire wall.
- 4.12.8 Fire Walls, Size of Opening Permitted. The aggregate size and location of openings in a fire wall shall be such that the protection against the spread of fire, strength, or stability of the fire wall is not reduced to less than that required. The size of such openings shall also comply with the following:
- 4.12.8.1 In Fire Walls in Sprinklered Buildings. Except as required for horizontal exits in 4.12.8.3, the size of openings in fire walls in sprinklered buildings shall be limited to the available approved opening protectives which have the required fire-resistance rating.
- 4.12.8.2 In Fire Walls in Unsprinklered Buildings. Except as required for horizontal exits in 4.12.8.3, no opening in a fire wall in an unsprinklered building may exceed 13.4 sq m in area, with no dimension greater than 3.7 m.
- 4.12.8.3 For Horizontal Exits. A fire wall which protects the area of refuge for a horizontal exit shall have no openings other than door openings, none of which shall exceed 4.5 sq m in area.
- 4.12.9 Fire Walls, Protection of Openings. All openings in a fire wall shall be provided with automatic or self-closing opening protective devices such as doors. Opening protectives in fire walls shall have an aggregate fire-resistance rating of not less than 3 hours for openings in fire walls required to have not less than a 3 hour fire-resistance rating, and have an aggregate fire-resistance of not less than 1-1/2 hours for openings in fire walls which may have less than a 3 hour fire-resistance rating.
- Each opening in a fire wall which has an opening protective on each side of the wall, and which serves as a horizontal exit shall have a self-closing fire door on one side of the opening, which shall swing in the direction of normal egress, when opening, and an automatic protective device on the other side of the opening.
- 4.12.10 Automatic Protective Device. Approved automatic opening protectives shall be designed and equipped to close automatically when the temperature of a heat-actuated device reaches not more than 74°C unless conditions compel otherwise, or at a predetermined rate of temperature rise, or by a fire-detecting device effective for the purpose. Such closing devices shall be so arranged that, when the doors are required on both faces of an opening, the doors on each face will close simultaneously.
- 4.12.11 Fire Door Need. Every opening in a fire wall requires a fire door. Openings shall be kept to a minimum required for normal operation.
- 4.13 Explosion Panels
- 4.13.1 Requirement. Explosion relief devices shall be required in buildings containing operations where combustible dusts can accumulate or high hazard areas where flammable gases, vapors, or mists, may be present in sufficient amounts to create explosive concentrations in air.

These areas are more specially defined in Section 7.0 as Class 1, 2, or 3 areas.

- 4.13.2 Vent Ratio. Explosive mixtures having a high rate of pressure rise will produce greater open vent pressure than explosive mixtures having a low rate of pressure rise, and will, therefore, require more vent area for effective venting. Vent ratio is the relationship of the area of the explosion panels to the volume of the equipment or room subject to internal explosions. The vent ratio, with a safety factor, shall be such that the weakest building or structure member shall not fail due to an internal explosion.
- 4.13.3 Swinging Panels
- 4.13.3.1 Light, hinged swinging panels are nearly as effective as unrestricted vents for the release of slow explosions such as coal dust, chlorinated solvents, etc. For rapid, violent explosions, any construction that will decrease the effectiveness of the vent and closures of high inertia shall be avoided. Counterweights shall be avoided.
- 4.13.3.2 Care must be taken to prevent closure of the vent opening after the initial positive pressure wave of the explosion subsides so as to prevent negative pressures as the remaining combustion products cool down.
- 4.13.4 Obstructions. Explosion panels shall not be obstructed by other objects, to interfere with proper operation of the vent.
- 4.13.5 Construction. The panels shall have the lowest feasible inertia. The release pressure needs to be as low as feasible relative to anticipated wind forces. The panels shall be restrained at one end by a hinge, chain or cable when flying panels may create new hazards. Panels shall not be of a material that tends to break into pointed shards (Pieces or fragments) such as glass or cement-asbestos type board. Consideration shall be given for indoor railings along floor edges near venting panels in order to prevent people from knocking the panels open and falling out.